2. Systematic observations of sea swells at Coast Guard stations on the southern Atlantic and Gulf coasts of the United States are now being taken daily during the hurricane season. Each situation on the coast, where observations of swell are made, has its own peculiarities, which should be carefully studied to ascertain the effect upon direction of swell and to determine whether the observations in that situation are sufficiently representative of ocean conditions to justify use of the data recorded.

3. Although systematic observations of swell are reported by ships at sea, the elements included in the reports are only direction and general character, but not the period. The direction is sometimes improperly recorded as that toward which the swells are moving rather than the direction from which they come. Cross seas in the storm field make it difficult in some cases to determine the dominant swell; in other cases the waves are so confused that the observations can show only that the sea is very rough.

4. Even on shore in excellent locations for observing sea waves, the storm swells are often confused by local waves so that it is difficult to determine the true direction and period of storm swells. At Galveston, for example, a tropical disturbance in the southwest Gulf of Mexico is likely to cause an increase in force and a change of the prevailing wind at Galveston to easterly, producing local waves of considerable size running across a light storm swell from the southeast or south. Oftentimes in such cases, however, the storm swell is discernible to the experienced observer.

5. When observations of swell on shore and on shipboard have been completely standardized and after adequate records have been accumulated for study, reports of sea swells should prove increasingly valuable in the hurricane warning service. Preliminary studies indicate that the elements of real value are direction and period of swell. The period of swell gives information as to the intensity of storm winds which cannot be obtained with any precision from descriptions of swells in terms of height and length.

6. As to observation of period of swell on shipboard, Cornish [8] stated, as a result of observation during voyages through the Caribbean Sea:

> It has been pointed out that a single observer upon a vessel under way can readily and quickly determine the period of the waves by noting the time taken by a patch of foam in falling and rising. If a swift running, slow heaving swell be present, its period of oscillation can also be determined by the foam spots, for the slower heave is easily watched, not, as might be expected, camouflaged by the shorter waves.

ACKNOWLEDGMENTS

The writer has used data supplied by Mr. Paul Watson of Galveston who has studied sea swells in connection with tropical storms for more than 25 years. Acknowledgment is also made of the assistance of Messrs. Earl C. Thom and Robert B. Evans of the Marine Division, who examined ships' observations and prepared maps from which some of the illustrations in this article were selected.

[8] Encyclopedia Brittanica, 14th edition. Waves of the Sea. Article by Vaughn Cornish, London, 1929.

TROPICAL DISTURBANCES, JULY 1936

By J. H. GALLENNE

[Weather Bureau, Washington, August 1936]

Two well-defined tropical disturbances occurred during July 1936. One crossed the Louisiana coast on the 27th; the other moved from the Atlantic through extreme southern Florida and passed inland east of Pensacola on the 31st. The synoptic weather map, Noon G. M. T., of July 27 is reproduced in chart IX, with the tracks of these two disturbances.

There were two other disturbed conditions originating over tropical waters, one during the period July 12 to 14, in the western Gulf of Mexico, and the other on July 22 near Puerto Rico; but neither appears to have developed more than slight intensity. The available reports do not show definite progressive movements to any considerable distances beyond the areas in which they were first observed.

July 26–28.—From the ships' weather observations taken at 7 a. m., E. S. T., on July 26, it was evident that there was a tropical disturbance in the southeastern portion of the Gulf of Mexico; and by 7 p. m. its position could be fixed, from ship reports, as being near latitude 26° north and longitude 89° west, with relatively slow movement in a northwesterly direction. At that time the disturbance appeared to be of slight intensity and confined to a small area, although there was a fairly definite cyclonic wind circulation. At 5 p. m. the S. S. *Davanger* near 26½° north, 88° west, reported squally weather, wind force 8, barometer 29.82 inches.

This depression moved on a north-northwesterly course during the next 12 hours, being located approximately 60 miles south of the coast of Louisiana, near the 90th meridian, at 8 a. m., E. S. T. of the 27th. At 7 a. m. the S. S. *San Gil*, at 28°15′ north and 89°30′ west, reported south-southeast winds of force 5 (Beaufort scale) with barometer reading 29.76 inches.

During the early afternoon of the 27th, the disturbance moved inland over southern Louisiana. At Delta Farms, Lafourche Parish, the lowest pressure was 29.62 inches (corrected) at 1:30 p. m. E. S. T. This is the lowest barometer reading of record during the progress of the disturbance. It was accompanied by an estimated wind velocity of 50 miles an hour. At the New Orleans Weather Bureau Office, a short distance to the right of the path of the center, the lowest pressure was 29.74 inches, at 5 p. m. on the 27th. Advancing farther inland with a recurve to the northeastward, the disturbance moved into Mississippi and dissipated on July 28.

Storm warnings for the Louisiana coast were issued at 9:15 a. m. E. S. T. on July 27 and all interests were advised to prepare for storm winds and rising tides. The conditions which occurred during the afternoon were fully and accurately heralded in the bulletin disseminated by the forecaster at New Orleans at 12:30 p. m., E. S. T.:

> July 27. Bulletin 12:30 p. m. E. S. T.: Tropical storm is turning northward and will move inland during next few hours over Lafourche and eastern Terrebonne Parishes, La., attended by shifting gales from Grand Isle westward to near Houma, La., with tides considerably above normal in area named.

There was no loss of life, and no important storm damage was reported.

July 27–August 1.—The history of this disturbance is not clearly shown by the observations until the morning of July 27 when a well-formed but weak cyclonic circulation was charted a short distance south of Cat Island, Bahamas. Progressing on a west-northwesterly course, with increasing intensity, the disturbance crossed Andros

Island at 5 a. m. on the 28th. The S. S. *Atenas* passed through a calm area between the hours of 6:15 p. m. and 7:15 p. m., E. S. T., on this date, while in the vicinity of latitude 25° north and longitude 80° west. The lowest barometer reported by this ship was 29.38 inches. At 7 p. m., E. S. T., the S. S. *Tiger*, a short distance from the *Atenas*, reported a barometer reading of 29.48 inches with a northwest gale of force 9 (Beaufort scale), clear weather, heavy rough sea, and squalls. An hour later, this same ship, giving her position as off Molasses Reef, reported clear sky, southwest gale, rising pressure, 29.54 inches.

With estimated wind velocities of 60 miles an hour near its center, the storm reached the southern tip of the Florida mainland about 30 miles south of Miami at 8 p. m. The Weather Bureau Office at Miami reported a maximum wind velocity of 44 miles an hour from the southeast, while the Miami Airport Station gave east-southeast winds of 49 miles an hour with gusts of 65 miles an hour.

Between 9:30 and 10 p. m., E. S. T., the storm center passed over Homestead and Florida City, maintaining a west-northwesterly course, with a progressive movement of about 10 to 12 miles an hour. The center then moved to the Gulf of Mexico; and at 8 a. m., E. S. T., of the 29th was located at approximately 26° north and 82°15′ west.

The following is taken from the report of G. E. Dunn, forecaster at Jacksonville.

* * * The center of the storm passed a short distance south of Everglades City where a barometer reading of 29.51 inches (possibly the barometer fell still lower later) was reported at 2 a. m. with 55 miles northeast wind. Following the passage of the axis of the center an abnormally high tide occurred and by morning the tide was 5.5 feet above mean low and the water was 18 inches deep in the streets of the town at normal low tide. During the forenoon winds of about 60 miles prevailed in the Boca Grande section but with little damage.

At 3:30 p. m. hurricane warnings were ordered north of Cedar Keys to Apalachicola and were later extended westward as the storm made no further recurve. As the storm approached the northwest Florida coast its rate of movement decreased and north of Cedar Keys and especially from St. Marks westward abnormally high tides were produced considering the size and intensity of the disturbance. This was probably due to the slow movement of the storm in this area, giving the wind ample time to pile up the water along the coast. * * *

At 11 o'clock, E. S. T., on the morning of July 31, the storm had crossed the northwest Florida coast and was centered over Valparaiso, a community on the northern shore of Choctawhatchee Bay, situated about 45 miles east of Pensacola. Reports from Valparaiso at 9 a. m. gave a barometer reading of 28.80 inches attended by east-northeast winds, estimated at 90 to 100 miles an hour. The barometric minimun, 28.73 inches, occurred there at 11 a. m., E. S. T. The calm center was over Fort Walton and Valparaiso about 1 hour and 20 minutes.

From the report of R. A. Dyke, forecaster at New Orleans:

* * * The hurricane winds extended on the coast line for about 70 miles but when allowance is made for the angle at which the storm reached the coast, the hurricane winds may be accepted as covering a width of not much over 50 miles directly across the path of the storm. * * *

As the storm moved in, the storm tide reached a height of approximately 6 feet at Panama City and Valparaiso. * * *

With rapidly diminishing intensity, after passing inland, the storm continued to move northwestward, and was centered just north of Pensacola at 8 p. m., E. S. T., of July 31. It dissipated on August 1 over the southwestern portion of Alabama.

The Weather Bureau forecasters at Jacksonville and at New Orleans issued timely warnings and bulletins relative to the intensity and movement of this disturbance. The first advice was disseminated at 9:30 a. m., E. S. T., of July 27 and advisories and bulletins followed at frequent intervals thereafter, until the storm had dissipated. In all sections affected the display of warnings preceded the arrival of the storm by 12 to 24 hours. Reports indicate property damage was slight as the storm crossed the lower portion of Florida. In the vicinity of Valparaiso and in nearby coastal sections, property damage was placed at $123,000, as a result of wind and storm tides. Quoting again from the report of G. E. Dunn:

The fishing boat *Ketchum* was apparently lost in the Gulf with 4 persons aboard but no other loss of life directly attributable to the storm in the Jacksonville district has been reported. Fortunately most of the sponge fleet was in port but the Coast Guard plane at St. Petersburg identified and warned 11 sponge and fishing vessels involving 40 persons and a total value of $22,000 in the storm area. The *Ketchum* left port on the 23d before the first advisory was issued and was outside the area searched by the Coast Guard plane. * * *

DUSTSTORMS OF JULY 1936 IN THE UNITED STATES

By R. J. MARTIN

[Weather Bureau, Washington, August 1936]

July had only a few duststorms, mostly local in character; with one or two exceptions, they were confined to the area between the Mississippi River and the Rocky Mountains. East of the Mississippi there were only a few scattered reports of dusty conditions.

Dense dust was reported locally over the Great Plains from Texas northward to the Canadian border, but the number of occurrences was small—in most States the average for the month was less than two storms, while in several others only light dust was noted. For example, Minnesota reported no dense dust; and only one station, in the extreme western portion of the State, observed light dust. Oklahoma, Kansas, and Nebraska, the Dakotas, Iowa, Montana, and Wyoming were among the States experiencing dense dust during July.

At Havre, Mont., visibility was reduced to about one-half city block for 3 minutes on the 17th; the storm of the 19th at Sioux City, Iowa, reduced visibility to 300 feet for a brief period, and was followed by rain. Automobile lights were necessary at times in Sioux City during this storm; and similar conditions prevailed at Helena, Mont., on the 14th. General rains on the 27th terminated dusty conditions in southeastern counties of Colorado.

Unless the storms of August are more frequent and severe, the next issue of the REVIEW will have no duststorm summary.